# CHAPTER 6
# ALTERNATIVES CONSIDERED

## DEVELOPMENT OF ALTERNATIVES

The Reclamation team, in cooperation with the NDTST, used information from Phase I, from Chapter 5 of this report, and from other sources to develop a range of reasonably viable alternatives. A "Future Without" condition was identified, which is essentially the same as Reclamation's 2050 projected demands identified in Phase I (as modified herein) . Based on the information in Chapter 5 (Features Considered) the most cost-effective and environmentally effective features were chosen in the alternative formulation process. The team developed three in-basin alternatives and three Missouri River import alternatives (seven, counting suboptions). These alternatives are described in this chapter and evaluated in chapter 7.

## ALTERNATIVE 1 — NO ACTION ("FUTURE WITHOUT")

The "Future Without" is intended to represent the most likely future condition in the study area if no new major water supply project is constructed. This includes water available from local utility-sponsored changes currently in progress or likely to be constructed.

Without a project, it is likely that the municipalities will increase water conservation by the year 2050, which is estimated to reduce projected future demand by about 15 percent as described in the Feature 12 section of chapter 5. It is also expected that emergency drought plans, as described for Feature 13, will be implemented and that a minimum pool in Lake Ashtabula storing 28,000 acre-feet will be dedicated to emergency drought response.

Water quality, which is already poor, will likely get worse, while the cost for treating water to higher standards will continue to increase.

For modeling the "Future Without" alternative, Reclamation's projected future demands are used. These were based on average annual demands, which were distributed monthly based on average historic variations in monthly water use. The demand data base used in the model does not account for variations in annual demand, which can increase 15 to 20 percent above the average demand during dry years. It is anticipated that these annual increases will be mostly offset by an active water conservation program, bringing these peak dry-year demands down close to the average demand projection. In view of this, no additional demand reduction for conservation is included in the "Future Without" or any of the action alternatives. Developing and using variable demand data should be reassessed in any more detailed studies that follow this appraisal report.

The study area will experience periods of drought in which projected water demands cannot be met. To provide a level of emergency supply, a minimum pool in Lake Ashtabula of 28,000 acre-feet (elevation 1257 feet) is reserved, coinciding with the present operating rules used by the Corps of Engineers.

In the hydrologic model of the "Future Without," Lake Ashtabula begins with one-half of the active conservation pool filled. This "half-full" pool level is 47,300 acre-feet (the 28,000-acre-foot minimum pool plus one-half of the 38,600 acre-foot conservation pool). This is considered appropriate since present demand levels are significantly lower than the projected demands for the year 2050, which are being modeled. To start the 54-year simulation (1931–1984) with Lake Ashtabula at minimum pool (elevation 1257) would imply that a very severe drought immediately precedes the modeled 1930's-style drought. This was considered to be too severe an assumption for the "design drought." The major parameters for this alternative are summarized as follows:

- Start with Phase 1A Baseline, as revised.
- Start with Lake Ashtabula active conservation pool half-filled (19,300 acre-feet conservation storage, 47,300 acre-feet total storage).
- Reserve Ashtabula minimum pool (28,000 acre-feet) for drought contingency.
- Include conservation. This is about a 15% reduction in demand; however, it is offset by a 15% to 20% increased demand in drought years.

The current maintenance costs for the existing Garrison Diversion Unit (GDU) facilities are included in all alternatives, including "No action," since the costs of continued minimum maintenance are far less than the costs of abandonment and site restoration. These maintenance costs are summarized in table 6.1, along with additional GDU costs that apply only to the alternatives that make use of the existing GDU facilities (alternatives 7A through 8).

## ALTERNATIVE 2— IN BASIN, INCLUDING KINDRED RESERVOIR

This is an in-basin alternative that adds storage capacity in the form of a new reservoir on the Sheyenne River near Kindred (figure 6.1). It incorporates five features (as described in chapter 5):

Feature 2 — Additional Sheyenne River storage in a new reservoir near Kindred . Model results show a Kindred Reservoir size at 84,000 acre-feet is needed to meet the shortages during the critical 1930's-style drought.

Feature 4C — A water-supply pipeline from the new reservoir to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 5 — A 22,000-acre-foot ring-dike reservoir near Fargo to store high spring flows from the Red River. Requires a high-capacity (400-cfs), low-head pumping plant

**Table 6.1.—Garrison Diversion Unit Operations and Maintenance Costs Included in Estimates for All Alternatives**

| GDU Component | Annual Cost (dollars) |
|---|---|
| Current maintenance for ALL alternatives: | |
| Snake Creek Pumping Plant | 233,000 |
| McClusky Canal | 1,103,000 |
| New Rockford Canal | 350,000 |
| Fish and Wildlife Mitigation | 453,000 |
| **Total for Alts. 1–6** | **2,139,000** |
| Additional Components, Alts. 7A–8: | |
| SCADA System [1] | 233,000 |
| Wintertime Operations | 52,000 |
| **Total for Alts. 7A, 7C, 7D, and 8** | **2,424,000** |
| McClusky Canal Miles 62–74 (Alt. 7B only) | [2] 154,000 |
| **Total for Alt. 7B** | **2,578,000** |

[1] Supervisory Controls and Data Acquisition System.
[2] Difference between cost of maintaining miles 62–74 in their current abandoned state ($50,000, included above under "current maintenance") and cost of maintaining this reach as an active waterway ($204,000).

to take advantage of short-duration high spring flows. Water in the ring dike can be released later in the year for use by Fargo, Moorhead, or New Industry 2. No specific site has been selected for the ring dike, but it is assumed to be within 1 mile of the river channel.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.2) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

These additional parameters also apply to Alternative 2:

! Both Lake Ashtabula and the new Kindred Reservoir start half full (Ashtabula at 47,300 acre-feet, Kindred at 42,000).
! The ring-dike reservoir near Fargo starts half full (11,000 acre-feet).
! The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930's.
! No minimum pool is designated for Lake Kindred.
! Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

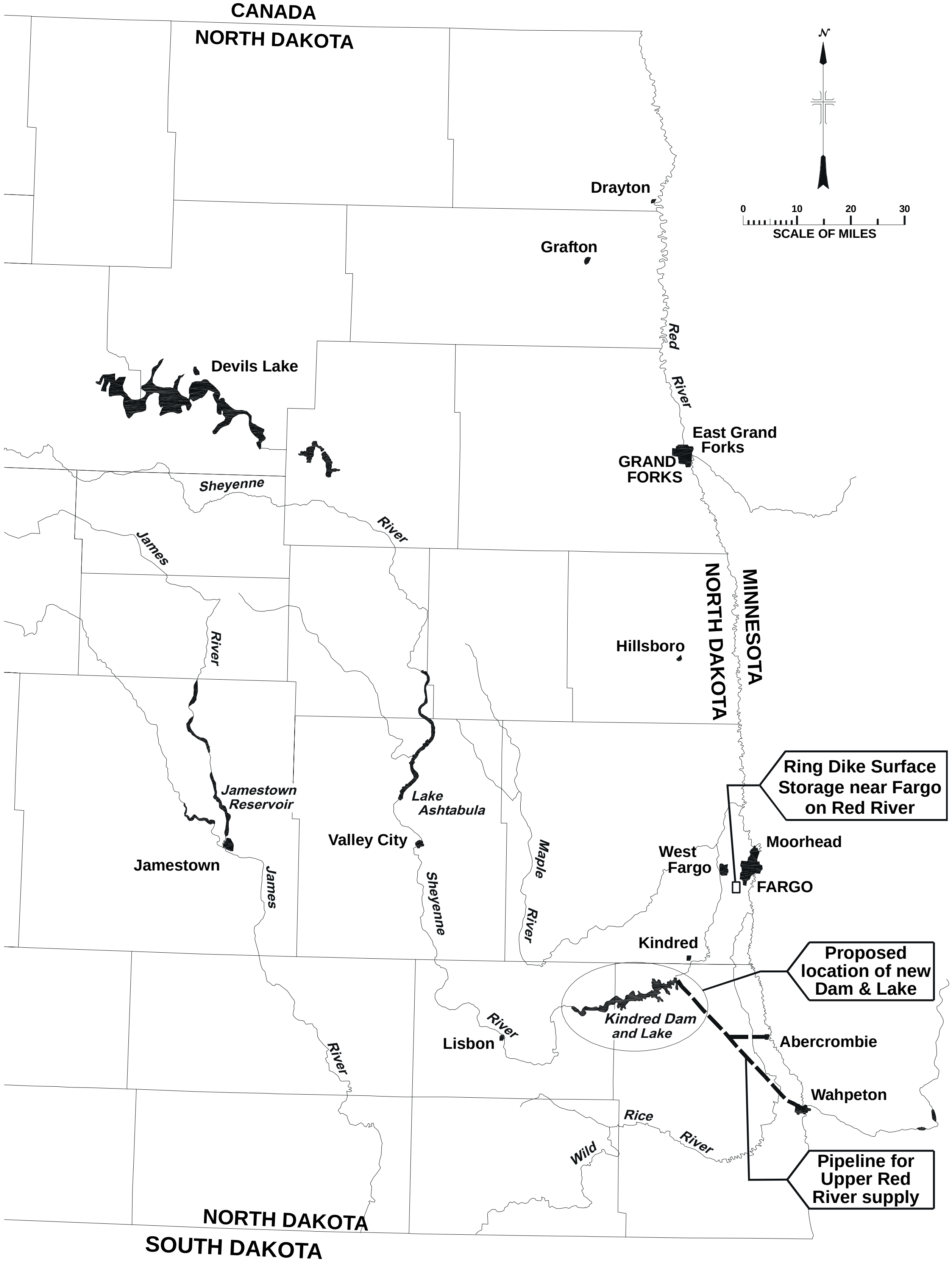


**Figure 6.1.—Alternative 2: new reservoir on Sheyenne River near Kindred, pipeline to upper Red River, and ring-dike reservoir on Red River.**

This alternative meets all of the projected 2050 Reclamation demands. Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year (284,360 acre-feet during the 10-year drought event).

Kindred Reservoir was sized to provide needed MR&I water for the year-2050 shortages; its entire capacity (84,000 acre-feet) is used during the modeled drought period (corresponding to the 1930s). The calculated end-of-month contents show the reservoir to be full in May and June of 1932 and in April and May of 1933, but then not again until April 1942. It is completely empty in March 1936 and throughout the period from November 1936 through March 1937. Additional reservoir functions such as recreation, power potential, flood control, etc, have not been studied at this level.

Shortages on the Upper Red River are met by transferring water from Kindred Reservoir and discharging into the Red River for use by M&I customers. This transfer pipeline begins with an 18-cfs pumping plant at Kindred Reservoir and is sized to deliver 9 cfs at Abercrombie and 9 cfs at Wahpeton. The ring dike on the Red River is assumed to be near Fargo and is used to capture high spring flows for later release to supply demands during low flow times. The ring dike diversion requires a high-capacity, low-head pumping plant to take advantage of short-duration high spring flows. This 400-cfs pumping plant, along with land and relocation costs, are included in the cost of this feature (table 6.2).

**Table 6.2.—Alternative 2 Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Kindred Dam & Reservoir | 51,100,000 | 250,000 | 3,890,000 |
| Dam & Reservoir ROW | 7,966,000 | (included above) | 570,000 |
| Roads and Bridges | 9,434,000 | (included above) | 670,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (39.6 mi) | 44,000,000 | 413,000 | 3,550,000 |
| 22,000-Acre-Foot Ring Dike on Red River | 56,810,000 | 222,000 | 4,270,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| Existing GDU Maintenance[1] | | 2,139,000 | 2,140,000 |
| **Totals** | **273,995,000** | **6,396,000** | **25,930,000** |

[1] See table 6.1.

## ALTERNATIVE 3 — IN BASIN, ENLARGED LAKE ASHTABULA

This is an in-basin alternative that adds storage capacity by raising the height of Bald Hill Dam and thereby increasing the size of Lake Ashtabula (figure 6.2). It incorporates seven features (as described in chapter 5):

Feature 1 — Enlargement of Lake Ashtabula to provide additional storage on the Sheyenne River. The model results show that the maximum pool size that could be attained at any point during a 1930s-style drought would be 120,000 acre-feet (compared to the existing 66,600-acre-foot pool). A reservoir of this capacity can be created with about a 9-foot raise of the reservoir's maximum water surface.

Feature 4C — A water-supply pipeline from the Sheyenne River near Kindred to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 5 — Two 22,000-acre-foot ring-dike reservoirs to store high spring flows—one on the Red River near Fargo and one on the lower Sheyenne River. The Red River ring-dike reservoir requires a high-capacity (400-cfs), low-head pumping plant to take advantage of short-duration high spring flows; the one on the Sheyenne requires a 200-cfs low-head pump. Water in the ring dikes can be released later in the year for use by Fargo, West Fargo, Moorhead, or New Industry 2. No specific sites have been selected for the ring dikes, but they are assumed to be within 1 mile of the river channel.

Feature 7 (modified) — Secure additional ground water from the Spiritwood Aquifer. This feature is required to meet projected future shortages for rural water systems and for new industry 5. The rural system that would use this well field is the Dakota Water Users. The projected shortage is met without construction of an extensive pipeline transmission system. No additional treatment plant costs are incurred because the Dakota Water Users currently treat and deliver some Spiritwood Aquifer water. A cost estimate, based on 6,600 acre-feet of annual withdrawal, with booster pump and pipeline to Lake Ashtabula, as estimated from Feature 7, would be $25 million.

Feature 8 (modified) — Secure additional groundwater from the purchase of existing irrigation water rights in the Sheyenne Delta, Page/Galesburg, and Elk Valley aquifers. The main aquifers described in Feature 8 as possible groundwater sources for municipal systems can be considered as sources for *rural* water systems by the water right transfer estimate. The rural water systems currently hold groundwater appropriation rights in these same aquifers; therefore, this action would simply be an expansion of their existing water source.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

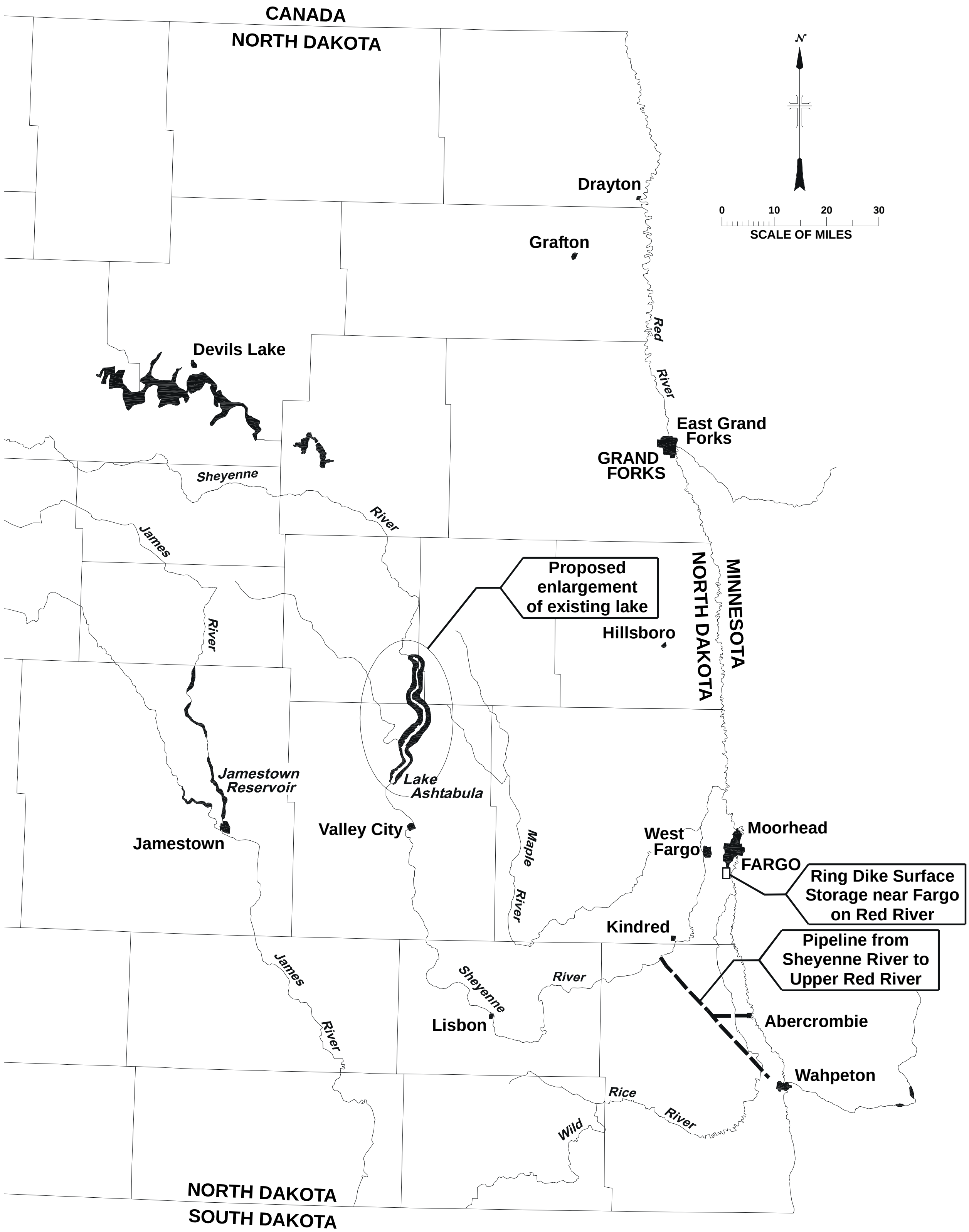


**Figure 6.2.—Alternative 3: enlarged Lake Ashtabula, pipeline to upper Red River, and ring-dike reservoir on Red River.**

These additional parameters also apply to Alternative 3:

- The enlarged Lake Ashtabula is started at one-half of the active conservation pool, which is approximately 74,000 acre-feet of volume.
- The ring-dike reservoir near Fargo is started half full (11,000 acre-feet).
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. As a result, this alternative has a reserve available in case of a drought even more severe than that of the 1930's. The minimum reservoir content during the 1930's drought is 27,590 ac-ft.
- Existing water-storage allocation plans are modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought. The most significant impact is the release of Grand Forks' allocation for use by others. The Grand Forks water supply is subsequently made up of return flows on the Red River.

This alternative meets all of the projected 2050 Reclamation demands. Due to the limited inflow to Lake Ashtabula during the critical years of the modeled drought period, a reservoir larger than 120,000 acre-feet would not fill. An enlarged Lake Ashtabula meets all of the future shortages without resorting to Dakota Aquifer water supplies; however, existing groundwater supplies have to be re-allocated from irrigation to rural water system uses. Cost estimates have been included for purchase of irrigation water rights (Feature 8) to make up the shortages of the rural water systems.

**Table 6.3.—Alternative 3 Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Enlarge Lake Ashtabula | 16,625,000 | 120,000 | 1,310,000 |
| ROW and Relocations | 8,900,000 | (included above) | 630,000 |
| Roads and Bridges | 13,500,000 | | 960,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (39.6 mi) | 44,000,000 | 441,000 | 3,580,000 |
| 22,000-Acre-Foot Ring Dike on the Red River | 56,810,000 | 222,000 | 4,270,000 |
| 22,000-Acre-Foot Ring Dike on the Sheyenne River | 45,310,000 | 163,000 | 3,390,000 |
| Spiritwood Aquifer Wellfield | 25,150,000 | 407,000 | 2,200,000 |
| Sheyenne Delta Aquifer [1] | 8,757,000 | 115,000 | 740,000 |
| Page/Galesburg Aquifer [1] | 12,310,000 | 174,000 | 1,050,000 |
| Elk Valley Aquifer [1] | 14,500,000 | 195,000 | 1,230,000 |
| GDU Maintenance [2] | | 2,139,000 | 2,140,000 |
| **Totals** | **245,862,000** | **3,976,000** | **21,500,000** |

[1] Includes water rights purchase and costs of wells, pumps, and pipelines.
[2] See table 6.1.

## ALTERNATIVE 4 — IN BASIN, GROUNDWATER ALTERNATIVE

This in-basin alternative (figure 6.3) is an attempt to meet the projected shortages without importing water and without changing or adding any major surface-water reservoirs. It relies instead on groundwater to supplement current surface-water supplies. It incorporates eight features (as described in chapter 5):

Feature 4 (modified) — A water-supply pipeline from *a ring dike on the Sheyenne River near Fargo* to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 5 (modified) — *Two* 22,000-acre-foot ring-dike reservoirs near Fargo—one on the Red River and one on the Sheyenne. Both require high-capacity, low-head pumping plants to take advantage of short-duration high spring flows—400 cfs for the reservoir on the Red River, but only 200 cfs for the one on the Sheyenne. Some of the water in the ring dikes may be pumped to the Upper Red River (Feature 4), some may be injected for aquifer storage (Feature 9), and some may be released later in the year for use by Fargo, West Fargo, Moorhead, or New Industry 2. No specific sites have been selected for the ring dikes, but they are each assumed to be within 1 mile of the associated river channel.

Feature 7 — A new well field in the Spiritwood Aquifer. This well field would be in northern Barnes County, and estimates suggest that it would yield 6,600 acre-feet per year. The groundwater would be pumped into Lake Ashtabula for reregulation to meet downstream shortages.

Feature 8 — Purchase of existing groundwater rights. As described in chapter 5, estimated yield from the Sheyenne Delta, Page/Galesburg, and Elk Valley Aquifers combined would be 8,690 acre-feet, assuming purchase of 33 percent of the existing irrigation wells.

Feature 9 — Aquifer storage and recovery using the West Fargo North Aquifer. This aquifer has approximately 10,000 acre-feet available for recharge and is located in an area where more water supplies are needed.

Feature 10 — Desalinization of water from Dakota Aquifer. Model run includes plant near Grand Forks producing 2 MGD. However, additional plants might also be used to make up remaining shortages.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.4) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

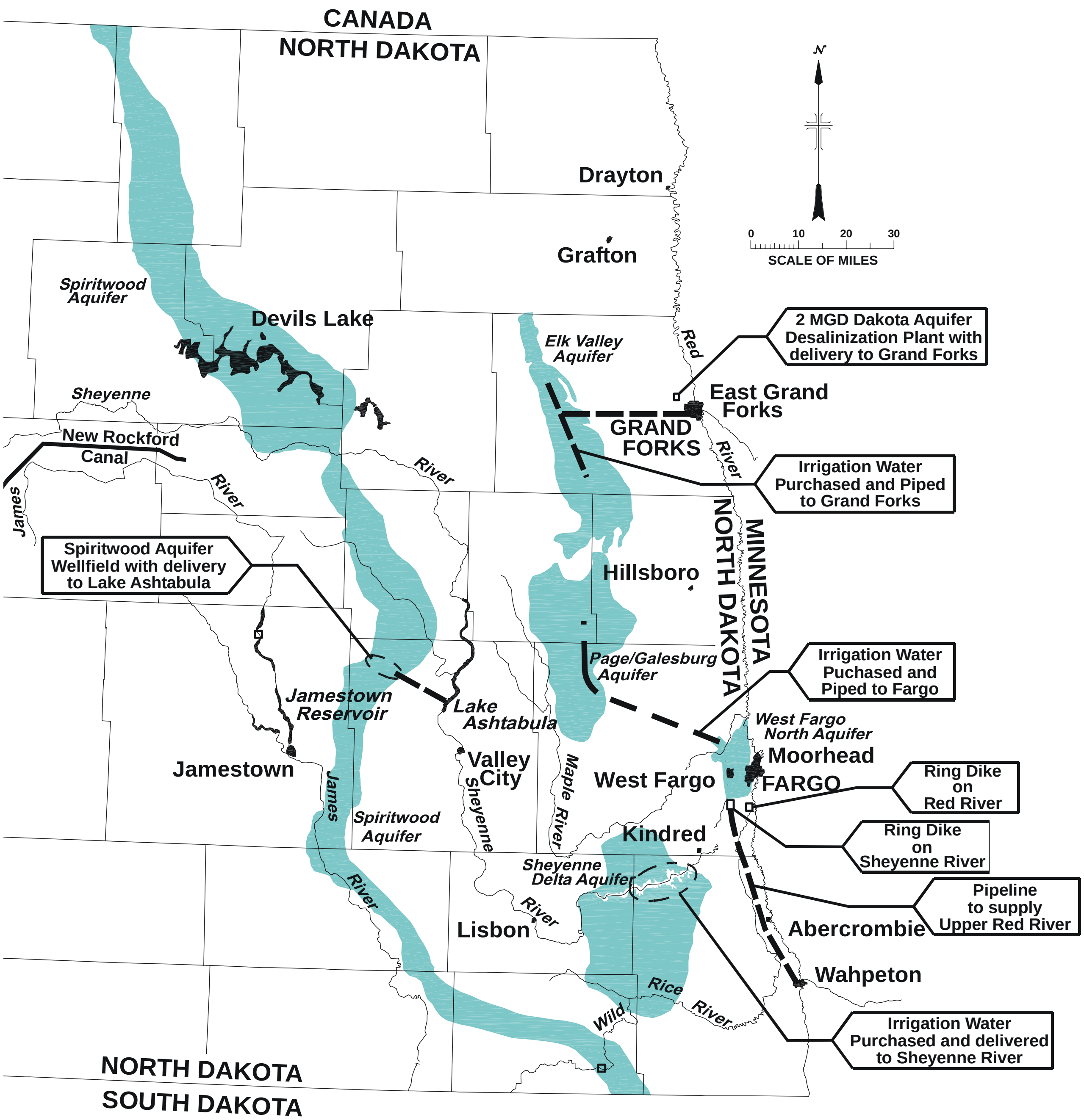


**Figure 6.3.—Alternative 4: Use of in-basin groundwater resources.**

These additional parameters also apply to Alternative 4:

- Lake Ashtabula starts at one-half of the active conservation pool, which is approximately 47,300 acre-feet of volume.
- Both ring-dike reservoirs start half full (11,000 acre-feet each).
- The aquifer storage facility (Feature 9) starts full (10,000 acre-feet).
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.

**Table 6.4.—Alternative 4 Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Spiritwood Aquifer Well Field | 25,150,000 | 532,000 | 2,330,000 |
| Page/Galesburg Aquifer Wells | 29,000,000 | 197,000 | 2,270,000 |
| Page/Galesburg Land Purchase | 5,922,000 | | 420,000 |
| Sheyenne Delta Aquifer Wells | 5,500,000 | 151,000 | 540,000 |
| Sheyenne Delta Land Purchase | 3,257,000 | | 230,000 |
| Elk Valley Aquifer Wells | 25,000,000 | 201,000 | 1,980,000 |
| Elk Valley Land Purchase | 5,542,000 | | 400,000 |
| West Fargo North Aquifer Storage and Recovery [1] | 12,500,000 | 391,000 | 1,280,000 |
| 22,000-Acre-Foot Ring Dike on the Red River | 56,810,000 | 222,000 | 4,270,000 |
| 22,000-Acre-Foot Ring Dike on the Sheyenne River | 45,310,000 | 158,000 | 3,390,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (54 mi) | 69,000,000 | 445,000 | 5,370,000 |
| 2 MGD Desalinization Plant at Grand Forks | 40,400,000 | 576,000 | 3,460,000 |
| Additional Desalinization Plants to supply all shortages | 442,430,000 | 10,545,000 | 42,100,000 |
| GDU Maintenance [2] | | 2,139,000 | 2,140,000 |
| **Totals** | **765,821,000** | **15,557,000** | **70,180,000** |

[1] Additional treatment plant capacity is not included here. Additional study may be required to determine if Fargo water treatment plant has "off-peak" capacity to treat for injection purposes.
[2] See table 6.1.

! Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

All groundwater withdrawals for this alternative are modeled at a steady rate based on either (a) the annual yields estimated for new well fields in the Spiritwood and Dakota Aquifers or (b) the annual volume of water rights transfers from the Elk Valley, Sheyenne Delta, and Page/Galesburg aquifers. The use of the West Fargo North Aquifer for aquifer storage and recovery adds approximately 10,000 acre-feet of water supply every year. The source of water for the aquifer storage and recovery system would be Red River high spring flows, which are initially stored in a ring-dike reservoir. This water will require treatment prior to injection. The rates of injection and recovery depend somewhat upon the aquifer characteristics; for this initial estimate, the assumption was that water would be injected during 9 months of the year (low demand times) and withdrawn during 3 months (high demand times). Each year the aquifer storage and recovery would utilize the full 10,000-acre-foot volume of water.

Use of the aquifer water supply may have some impact on the quality of the water that is treated by the existing municipalities. Ground water generally is hard and contains more TDS than the surface water supply. There is also greater potential of agrochemical (particularly nitrate) contamination of the ground water supply.

Desalinization of water from the Dakota Aquifer has been included in the Grand Forks area. This desalinization plant is estimated to be operating at a steady 2 MGD production rate. The desalinization water supply allows some of the Grand Forks water stored in Lake Ashtabula to be available to help meet other shortages.

**Table 6.5.—Desalinization Plants Modeled to Meet Shortages Under Alternative 4**

| Location | RO Plant Flow rate (MGD) | Treatment Plant Capital Cost ($) | Brine Rate (MGD) | Brine Pond Capital Cost ($) | O&M Cost ($/yr) |
|---|---|---|---|---|---|
| Fargo & West Fargo | 27.5 | 36,074,000 | 4.85 | 223,000,000 | 6,006,500 |
| Valley City | 1.2 | 2,463,000 | .21 | 12,600,000 | 407,600 |
| New Industry #5 | 5.2 | 8,146,000 | .92 | 44,600,000 | 1,271,400 |
| Agassiz, Tri-County, Walsh Rural Water | 0.8 | 2,039,000 | .14 | 9,400,000 | 347,800 |
| Cass Rural Water | 2.6 | 4,763,000 | .46 | 23,800,000 | 750,300 |
| Dakota Water Users | 1.0 | 2,254,000 | .18 | 11,000,000 | 377,600 |
| Grand Forks-Traill & Traill Water Users | 2.9 | 5,088,000 | .51 | 26,200,000 | 798,600 |
| Langdon Rural Water | .35 | 1,535,000 | .06 | 5,800,000 | 177,700 |
| Southeast & Ransom-Sargent Rural Water | 1.2 | 2,463,000 | .21 | 12,600,000 | 407,600 |
| **TOTAL** | | **64,825,000** | | **369,000,000** | **10,545,100** |

Note: An additional cost of $8.6 million is estimated for well construction, pumps, and pipelines to supply groundwater to the treatment plants. Therefore, total construction costs sum up as follows:

| | |
|---|---|
| Treatment plants . . . . . . | $ 64,825,000 |
| Brine ponds . . . . . . . . . . . | 369,000,000 |
| Wells, etc. . . . . . . . . . . . . | 8,600,000 |
| Total construction . . | $442,425,000 |

Additional development of the Dakota Aquifer is proposed to meet the remaining shortages of this model run. The Dakota Aquifer is fairly widespread, but the quality of its water is poor. To make a complete study area water supply, the alternative estimate includes additional desalinization (RO) plants for treating Dakota Aquifer water. Exact locations of Dakota Aquifer wells have not been identified, but the estimate is based on the assumption that wells could be located at or near the shortage sites. Before any such plants were built, a considerable amount of investigation would be needed to determine if adequate supplies would be available from the aquifer at the modeled locations. Table 6.5 shows these locations, the amount of water supply needed at each, and estimated costs of treatment.

## ALTERNATIVE 5 — IMPORT, BISMARCK TO FARGO PIPELINE

This is a Missouri River water import alternative with two suboptions for delivery of water to points on the Red River. Under both variations, this alternative brings water from the Missouri River near Bismarck and delivers it to Fargo and to the vicinity of Wahpeton (figure 6.4). The main difference between the suboptions is whether one or two ring-dike reservoirs are used to reregulate the imported water. Both alternatives include biota treatment by the ozonation/ chloramine process.

### Alternative 5A: 65-cfs Import to Two Ring-Dike Reservoirs near Fargo and Wahpeton

This Missouri River import alternative incorporates five features (as described in chapter 5):

Feature 4 (modified) — A water-supply pipeline *branching off directly from the main Bismarck-Fargo pipeline and delivering water to a small ring-dike reservoir near Wahpeton*.

Feature 5 (modified) — *Two* ring-dike reservoirs to store and reregulate imported water — one near Fargo (10,600-acre-feet) and one near Wahpeton (5,200 acre-feet). *Neither would include the river diversion pump described in chapter 5.*

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.6) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

Feature 18 (modified) — A *65-cfs* pipeline that transports Missouri River water from the Bismarck vicinity to *(1) a surface storage reservoir near Fargo and (2) a smaller pipeline (Feature 4) leading to a second storage reservoir near Wahpeton.* Includes a biota treatment plant at Bismarck using the ozonation/chloramine process.

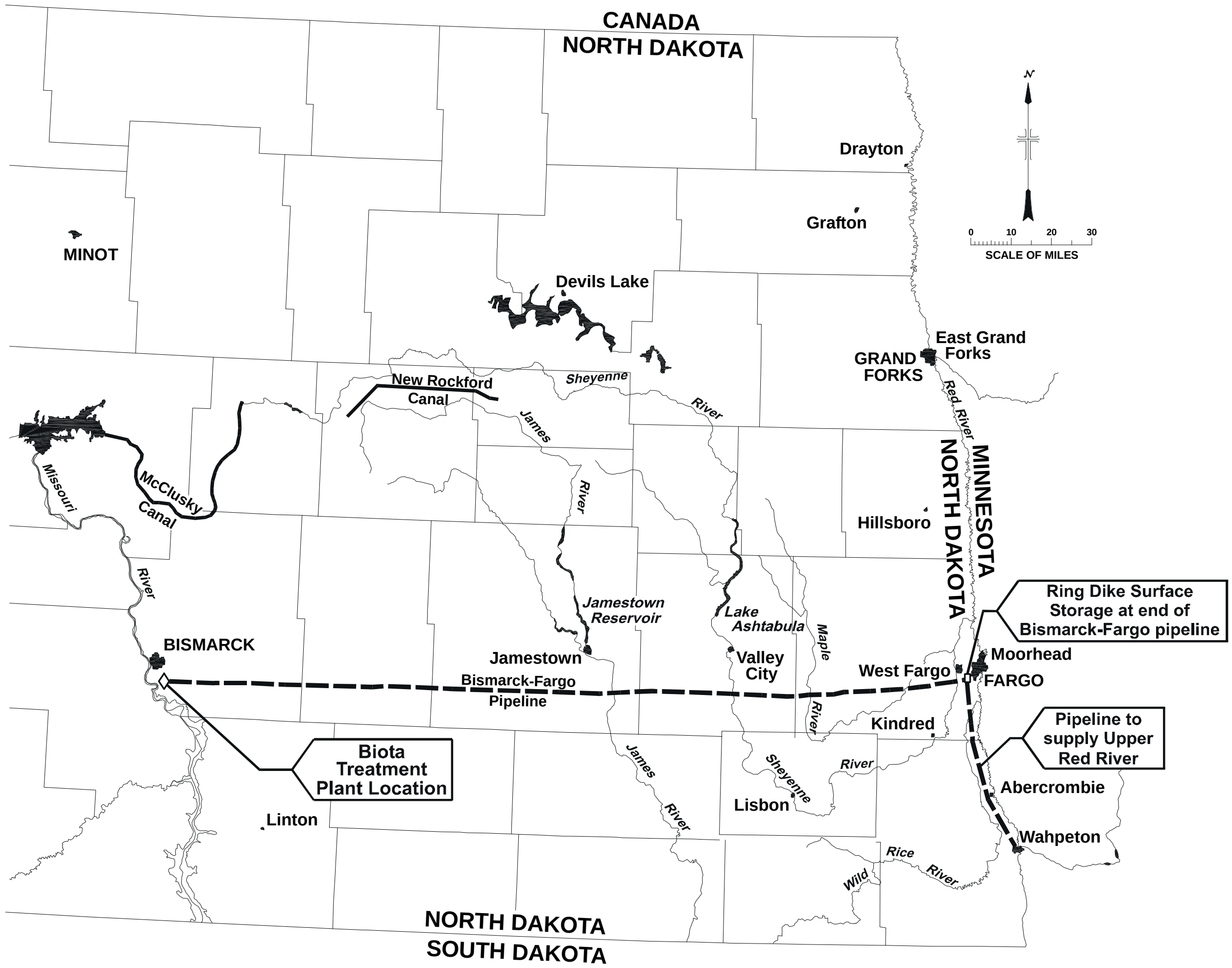


**Figure 6.4.—Alternative 5: Pipeline import to Fargo.**

These additional parameters also apply to Alternative 5A:

- Lake Ashtabula starts with the active conservation pool half full (47,300 acre-feet).
- Both ring-dike reservoirs start full (10,600 and 5,200 acre-feet, respectively).
- The pipeline and treatment plant operate at a steady 65 cfs year-round, and this flow is reregulated in the ring-dike reservoirs.
- The pipeline import is used to meet base demands at Fargo, West Fargo, Moorhead, Wahpeton, the Cargill plant at Wahpeton, and the future industry near Abercrombie; these cities and industries will rely on other water sources to meet peak demands.
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.
- Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

**Table 6.6.—Alternative 5A Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Bismarck-Fargo Pipeline 65 cfs | 463,000,000 | 3,690,000 | 36,710,000 |
| Biota Treatment Plant - Ozone @65 cfs capacity | 13,100,000 | 1,176,000 | 2,110,000 |
| 10,600-Acre-Foot Ring Dike near Fargo | 18,970,000 | 12,000 | 1,360,000 |
| 5,200-Acre-Foot Ring Dike near Wahpeton | 13,290,000 | 6,000 | 960,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (54 mi) | 69,000,000 | 445,000 | 5,370,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| Existing GDU Maintenance [1] | | 2,139,000 | 2,140,000 |
| Water Treatment Cost Savings | | –1,371,000 | –1,370,000 |
| **Totals** | **682,045,000** | **9,469,000** | **58,120,000** |

[1] See table 6.1.

This alternative meets all of the projected 2050 Reclamation demands. Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year. Most of this—47,000 acre-feet—is directly attributable to the import; the remainder results from improvements in storage capacity and distribution patterns.

Cost estimates in table 6.6 are based on operating both the import pipeline and the biota treatment plant at a steady rate year-round. The table also shows a cost savings for the Fargo municipal treatment plant, reflecting the lower amount of treatment required for imported Missouri River water, compared to the Red River water used now. (See “Raw Water Treatment Cost Analysis” in Appendix 2.)

## Alternative 5B: 70-cfs Import to a Single Ring-Dike Reservoir near Fargo

This Missouri River import alternative incorporates five features (as described in chapter 5):

Feature 4 (modified) — A water-supply pipeline from *a ring-dike reservoir near Fargo* to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 5 (modified) — A 22,000-acre-foot ring-dike reservoir near Fargo to store and reregulate water imported via the Bismarck-Fargo pipeline (feature 18). *Would not include the river diversion pump described in chapter 5.*

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.7) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

Feature 18 — A *70-cfs* pipeline that transports Missouri River water from the Bismarck vicinity to *a surface storage reservoir near Fargo*. Includes a biota treatment plant at Bismarck using the ozonation/chloramine process.

These additional parameters also apply to Alternative 5B:

- Lake Ashtabula starts with the active conservation pool half full (47,300 acre-feet).
- The ring-dike reservoir starts full (22,000 acre-feet).
- The pipeline and treatment plant operate at a steady 70 cfs year-round, and this flow is reregulated in the ring-dike reservoir.
- The pipeline import is used to meet base demands at Fargo, West Fargo, Moorhead, the Cargill plant at Wahpeton, and the future industry near Abercrombie; these cities and industries will rely on other water sources to meet peak demands.
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.
- Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

**Table 6.7.—Alternative 5B Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Bismarck-Fargo Pipeline 70 cfs | 490,000,000 | 3,877,000 | 38,820,000 |
| Biota Treatment Plant - Ozone @70cfs capacity | 13,800,000 | 1,260,000 | 2,240,000 |
| 22,000-Acre-Foot Ring Dike near Fargo | 28,810,000 | 12,000 | 2,070,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (54 mi) | 69,000,000 | 445,000 | 5,370,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| Existing GDU Maintenance [1] | | 2,139,000 | 2,140,000 |
| Water Treatment Cost Savings | | –1,371,000 | –1,370,000 |
| **Totals** | **706,295,000** | **9,734,000** | **60,110,000** |

[1] See table 6.1.

This alternative meets all of the projected 2050 Reclamation demands. Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year. Most of this—50,600 acre-feet—is directly attributable to the import; the remainder results from improvements in storage capacity and distribution patterns.

Cost estimates in table 6.7 are based on operating both the import pipeline and the biota treatment plant at a steady rate year-round. The table also shows a cost savings for the Fargo municipal treatment plant, reflecting the lower amount of treatment required for imported Missouri River water, compared to the Red River water used now. (See "Raw Water Treatment Cost Analysis" in Appendix 2.)

## ALTERNATIVE 6 — IMPORT, LAKE OAHE TO WAHPETON PIPELINE

This is a Missouri River import alternative that supplies treated water through a pipeline from Lake Oahe to the Red River near Wahpeton (figure 6.5). It incorporates four features (as described in chapter 5):

Feature 5 (modified) — A 22,000-acre-foot ring-dike reservoir near Wahpeton to store and reregulate water imported via the Oahe-Wahpeton pipeline (feature 16). *Would not include the river diversion pump described in chapter 5.*

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 16 — A 60-cfs pipeline that transports Missouri River water from Lake Oahe, west of Linton, ND, to a surface storage reservoir near Wahpeton. Includes a biota treatment plant at Lake Oahe using the ozonation/chloramine process.

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.8) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

These additional parameters also apply to Alternative 6:

- Lake Ashtabula starts with the active conservation pool half full (47,300 acre-feet).
- The ring-dike reservoir starts full (22,000 acre-feet).
- The pipeline and treatment plant operate at a steady 60 cfs year-round, and this flow is reregulated in the ring-dike reservoir
- The pipeline import is used to meet base demands at Fargo, West Fargo, Moorhead, the existing Cargill plant near Wahpeton, and the modeled future industries along the Red River; these cities and industries will rely on other water sources to meet peak demands.
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.

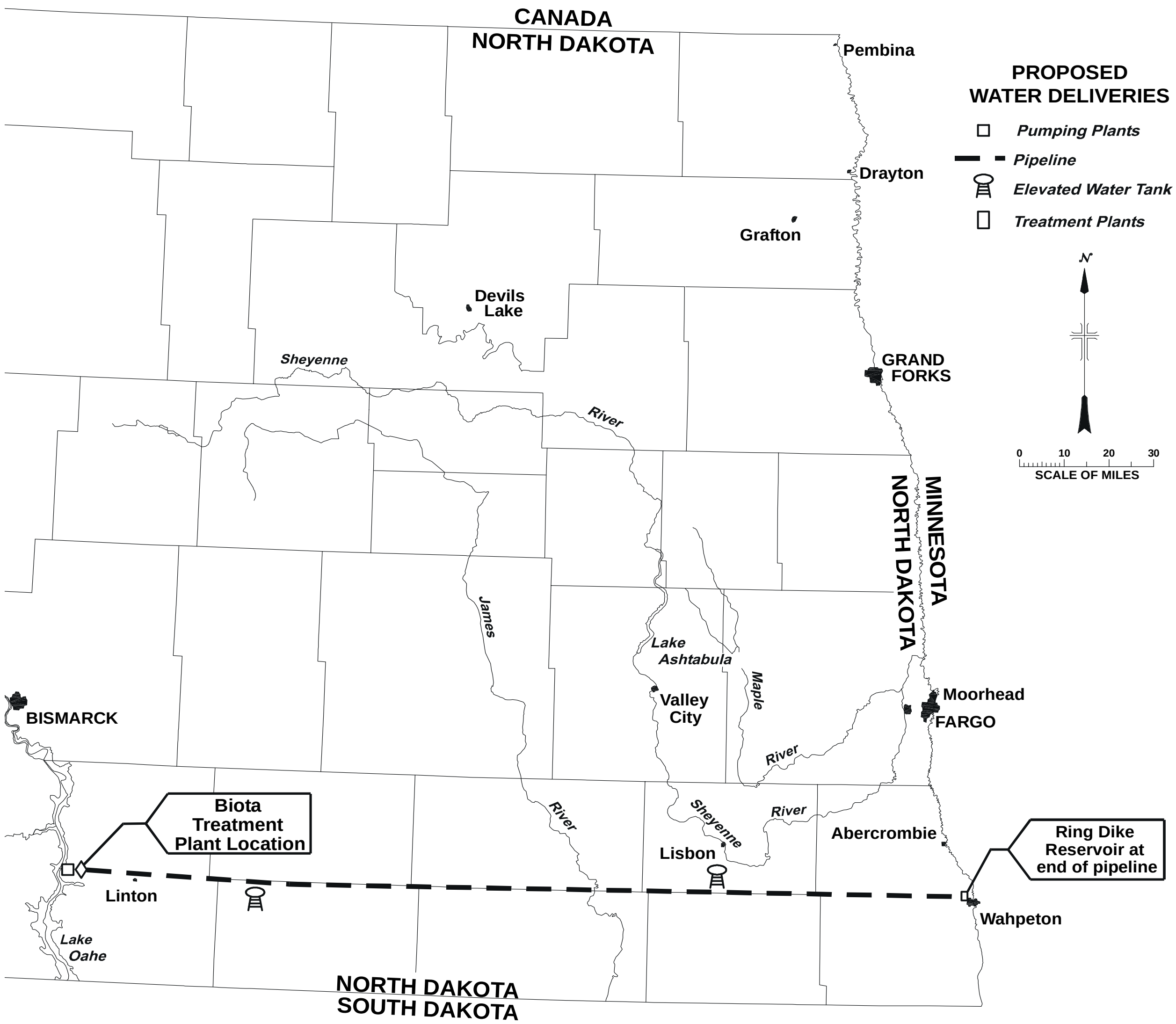


**Figure 6.5.—Alternative 6: Import to upper Red River.**

! Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

This alternative meets all of the projected 2050 Reclamation demands. Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year. Most of this—43,400 acre-feet—is directly attributable to the import; the remainder results from improvements in storage capacity and distribution patterns.

In modeling this alternative, shortages that existed on the Sheyenne River due to demands at Fargo, West Fargo, Moorhead, and New Industry 2 have been shifted to the Red River to be met by the import. Shifting demands to the Red River allows Lake Ashtabula to be used more effectively to meet shortages and demands that occur on the Sheyenne and Lower Red Rivers. The rural water system shortages that were consolidated into the single demand point at Fargo (representing systems in the southern part of the Red River Valley) have been included in the pipeline import.

Cost estimates in table 6.8 are based on operating both the import pipeline and the biota treatment plant at a steady rate year-round. The table also shows a cost savings for the Fargo municipal treatment plant, reflecting the lower amount of treatment required for imported Missouri River water, compared to the Red River water used now. (See “Raw Water Treatment Cost Analysis” in Appendix 2.) Because the imported water in this alternative mixes with Red River water in the channel between Wahpeton and Fargo, the treatment-cost savings is calculated at half of what it would have been for a direct pipeline import.

**Table 6.8.—Alternative 6 Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Lake Oahe to Wahpeton Pipeline 60 cfs | 450,000,000 | 3,760,000 | 35,850,000 |
| Biota Treatment Plant - Ozone @60 cfs | 12,400,000 | 1,090,000 | 1,970,000 |
| Ring Dike at Wahpeton | 28,810,000 | 12,000 | 2,070,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| Existing GDU Maintenance [1] | | 2,139,000 | 2,140,000 |
| Water Treatment Cost Savings | | –613,000 | –610,000 |
| **Totals** | **595,895,000** | **9,760,000** | **52,260,000** |

[1] See table 6.1.

## ALTERNATIVE 7 — IMPORT TO UPPER SHEYENNE USING FACILITIES OF GARRISON DIVERSION UNIT

This is a Missouri River water import alternative with four suboptions for water-supply routes. These imports all bring water from the McClusky Canal into the upper Sheyenne River and use the existing Lake Ashtabula as a reregulating reservoir. One of them (7D) also includes a pipeline import directly to Grand Forks. With an imported water supply to Lake Ashtabula, the existing water-storage allocation plans are modified and the conservation pool is operated as one storage pool. Shortages on the upper Red River are supplied with a pipeline connection from the Sheyenne River near Kindred to the Red River near Wahpeton. Biota treatment by the ozonation/chloramine process is included in all of these import alternatives.

### Alternative 7A: Steady 72-cfs Import Using McClusky and New Rockford Canals Connected by the Missouri Coteau (Pumped) Route

This Missouri River import alternative (figure 6.6) incorporates four features (as described in chapter 5):

Feature 4C — A water-supply pipeline from the Sheyenne River near Kindred to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 14A — Pipeline from McClusky Canal to New Rockford Canal via Missouri Coteau Route (35-mile route that stays entirely within the Missouri River basin and requires pumping); biota treatment by ozonation/chloramine process at end of New Rockford Canal; second pipeline from New Rockford Canal to Upper Sheyenne.

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.9) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

These additional parameters also apply to Alternative 7A:

- Lake Ashtabula starts with the conservation pool full (66,600 acre-feet). The justification for this is that if pipeline water is used for base demands, the Lake Ashtabula conservation pool can be reserved to meet peak demands.
- The treatment plant and the pipeline to the Sheyenne deliver a steady 72 cfs year-round, and this flow is reregulated in Lake Ashtabula.
- The first pipeline (McClusky Canal to New Rockford Canal) operates at 87 cfs to allow for 15 cfs of losses in the New Rockford Canal.
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.
- Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

This import alternative meets all of the projected 2050 Reclamation demands. Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year. Most of this—52,100 acre-feet—is directly attributable to the import; the remainder results from the greater reserves available in Lake Ashtabula at the beginning of the modeled drought period.

This alternative uses existing Garrison Diversion Unit supply works. Costs are included here (table 6.9) for updating and rehabilitation of those facilities, as provided by Reclamation's

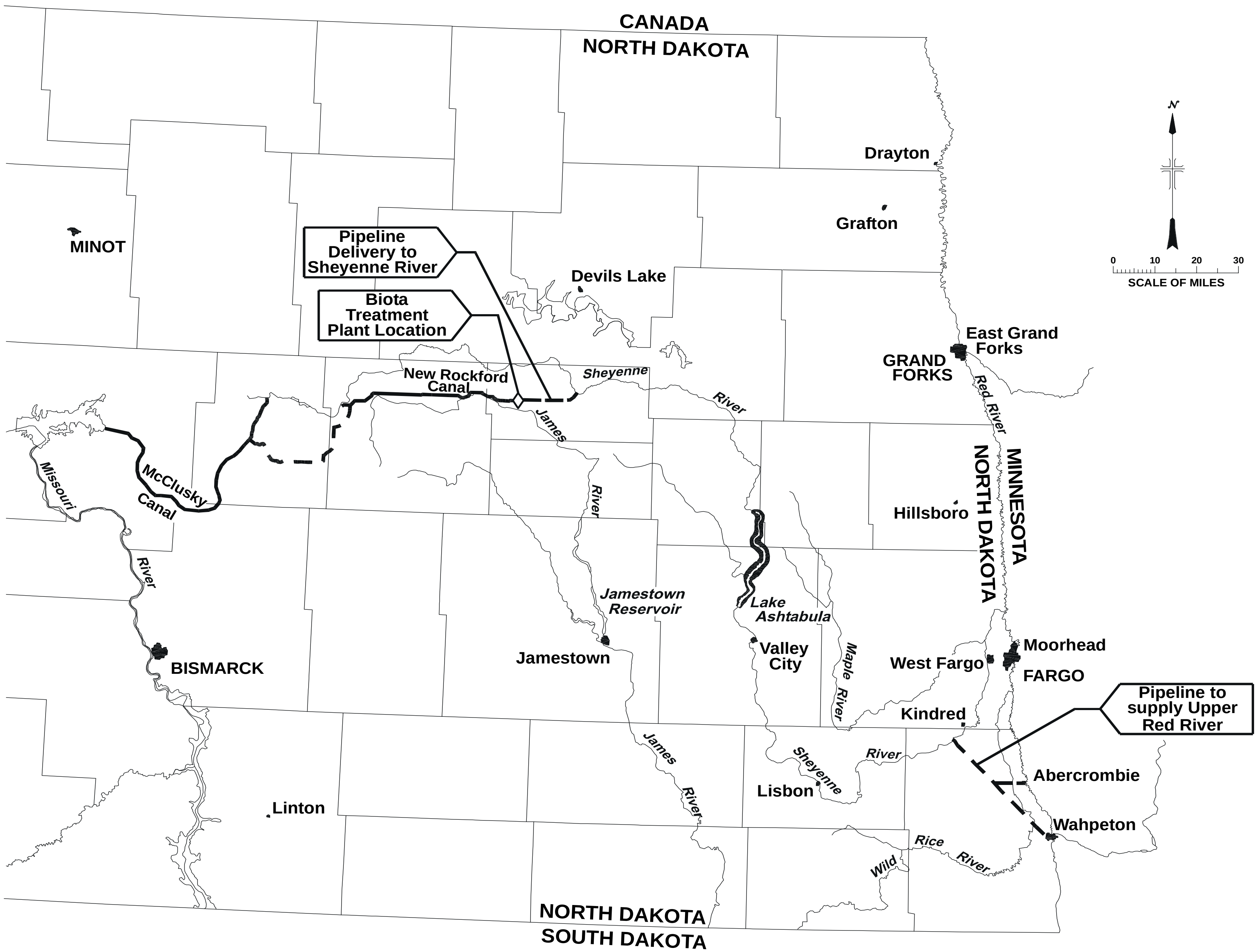


**Figure 6.6.—Alternative 7A: Import to upper Sheyenne River via Missouri Coteau (pumped) route.**

**Table 6.9.—Alternative 7A Cost Summary**
(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Snake Creek Pumping Plant Intake Channel | 5,100,000 | | 360,000 |
| McClusky Canal Rehab | 36,900,000 | | 2,630,000 |
| New Rockford Canal Rehab | 8,900,000 | | 630,000 |
| New Rockford Overflow Outlet | 7,000,000 | | 500,000 |
| 87-cfs Pumping Plant and 34.7-mi pipeline | 84,300,000 | 1,756,000 | 7,770,000 |
| 9.3-mi Pipeline@72 cfs (New Rockford Canal to Sheyenne River) | 24,200,000 | 54,000 | 1,780,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (39.6 mi) | 44,000,000 | 441,000 | 3,580,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| Biota Treatment Plant, Ozone/Chloramine @72 cfs | 14,100,000 | 1,294,000 | 2,300,000 |
| Existing GDU Maintenance [1] | | 2,424,000 | 2,420,000 |
| **Totals** | **329,185,000** | **9,341,000** | **32,810,000** |

[1] See table 6.1.

Dakotas Area Office, and also for constructing an emergency outlet for storm-water discharge from the New Rockford Canal.

Where possible, shortages on the Red River have been shifted to the Sheyenne River in order to take advantage of the import water supply. Feature 4C is sized to accommodate the shortages that remained on the upper Red River.

### Alternative 7B: Steady 72-cfs Import from End of McClusky Canal to Sheyenne River

This Missouri River import alternative (figure 6.7) incorporates four features (as described in chapter 5):

Feature 4C — A water-supply pipeline from the Sheyenne River near Kindred to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

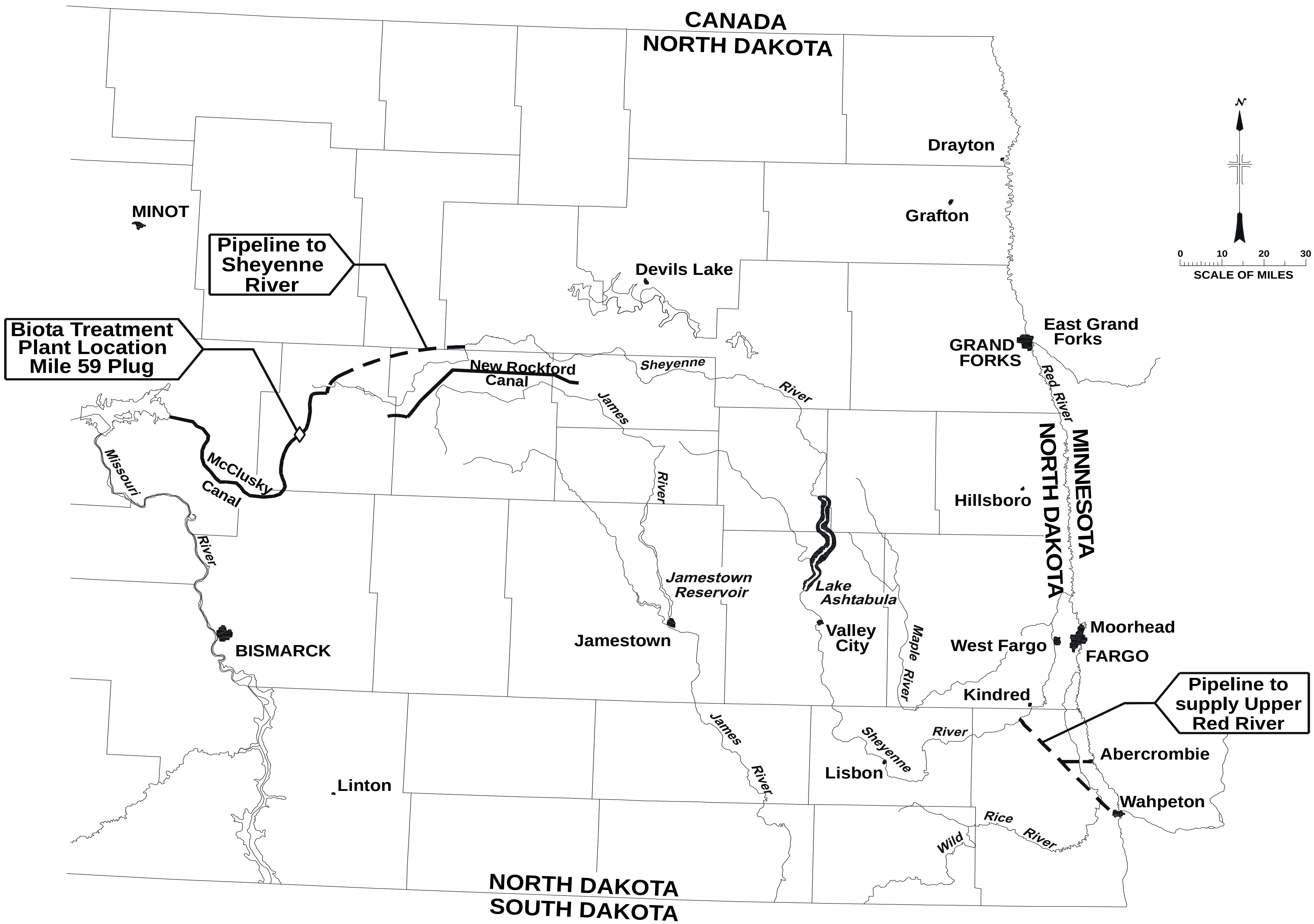


Figure 6.7.—Alternative 7B: Import to upper Sheyenne River directly from end of McClusky Canal.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 14C — Pipeline direct from McClusky Canal (mile 73) to confluence of the North and South Forks of the Sheyenne River (34-mile gravity-discharge route). Biota treatment by ozonation/chloramine process on McClusky Canal at mile 59 plug. The New Rockford Canal is not used.

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.10) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

These additional parameters also apply to Alternative 7B:

! Lake Ashtabula starts with the conservation pool full (66,600 acre-feet). The justification for this is that if pipeline water is used for base demands, the Lake Ashtabula conservation pool can be reserved to meet peak demands.

! The treatment plant and pipeline deliver a steady 72 cfs to the Sheyenne year-round, and this flow is reregulated in Lake Ashtabula.

! The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.

**Table 6.10.—Alternative 7B Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Snake Creek Pumping Plant Intake Channel | 5,100,000 | | 360,000 |
| McClusky Canal Rehab | 36,900,000 | | 2,630,000 |
| Biota Treatment Plant, Ozone/Chloramine @72 cfs | 14,100,000 | 1,290,000 | 2,300,000 |
| Pipeline, 34 mi.@72 cfs to Sheyenne River [1] | 71,200,000 | 170,000 | 5,250,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| 18-cfs Pumping Plant & Upper Red Pipeline (39.6 mi) | 44,000,000 | 440,000 | 3,580,000 |
| Existing GDU Maintenance [2] | | 2,578,000 | 2,580,000 |
| **Totals** | **275,985,000** | **7,850,000** | **27,540,000** |

[1] No detailed cost estimate available. Estimate based on Feature 14B cost per mile.
[2] See table 6.1.

! Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

This import alternative meets all of the projected 2050 Reclamation demands. Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year. Most of this—52,100 acre-feet—is directly attributable to the import; the remainder results from the greater reserves available in Lake Ashtabula at the beginning of the modeled drought period.

This alternative uses some of the existing Garrison Diversion Unit supply works. Table 6.10 includes costs for updating and rehabilitation of the Snake Creek Pumping Plant and the McClusky Canal, as provided by Reclamation's Dakotas Area Office, but does not include costs for the New Rockford Canal or its overflow outlet.

The import water reaches the Sheyenne River at the junction of the North Branch and the main stem. It has been assumed that this junction is a logical location where the river channel would begin to have sufficient capacity to accept this amount of import flow. The actual capacity of the river channel and any need for bank stabilization or erosion control have not been assessed for this appraisal-level study. This pipeline would flow by gravity and represents the shortest practicable route for getting supplemental water into the Sheyenne River.

Where possible, shortages on the Red River have been shifted to the Sheyenne River in order to take advantage of the import water supply. Feature 4C is sized to accommodate the shortages that remained on the upper Red River.

### Alternative 7C: Steady 72-cfs Import Using McClusky Canal and New Rockford Canal Connected by the Northern (Gravity Flow) Route

This Missouri River import alternative (figure 6.8) incorporates four features (as described in chapter 5):

Feature 4C — A water-supply pipeline from the Sheyenne River near Kindred to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 14B — Pipeline from McClusky Canal to New Rockford Canal via Northern Route (22-mile route that crosses into and out of Hudson Bay drainage and allows pipeline to flow by gravity); biota treatment by ozonation/chloramine process at both McClusky Canal and end of New Rockford Canal; second pipeline from New Rockford Canal to Upper Sheyenne.

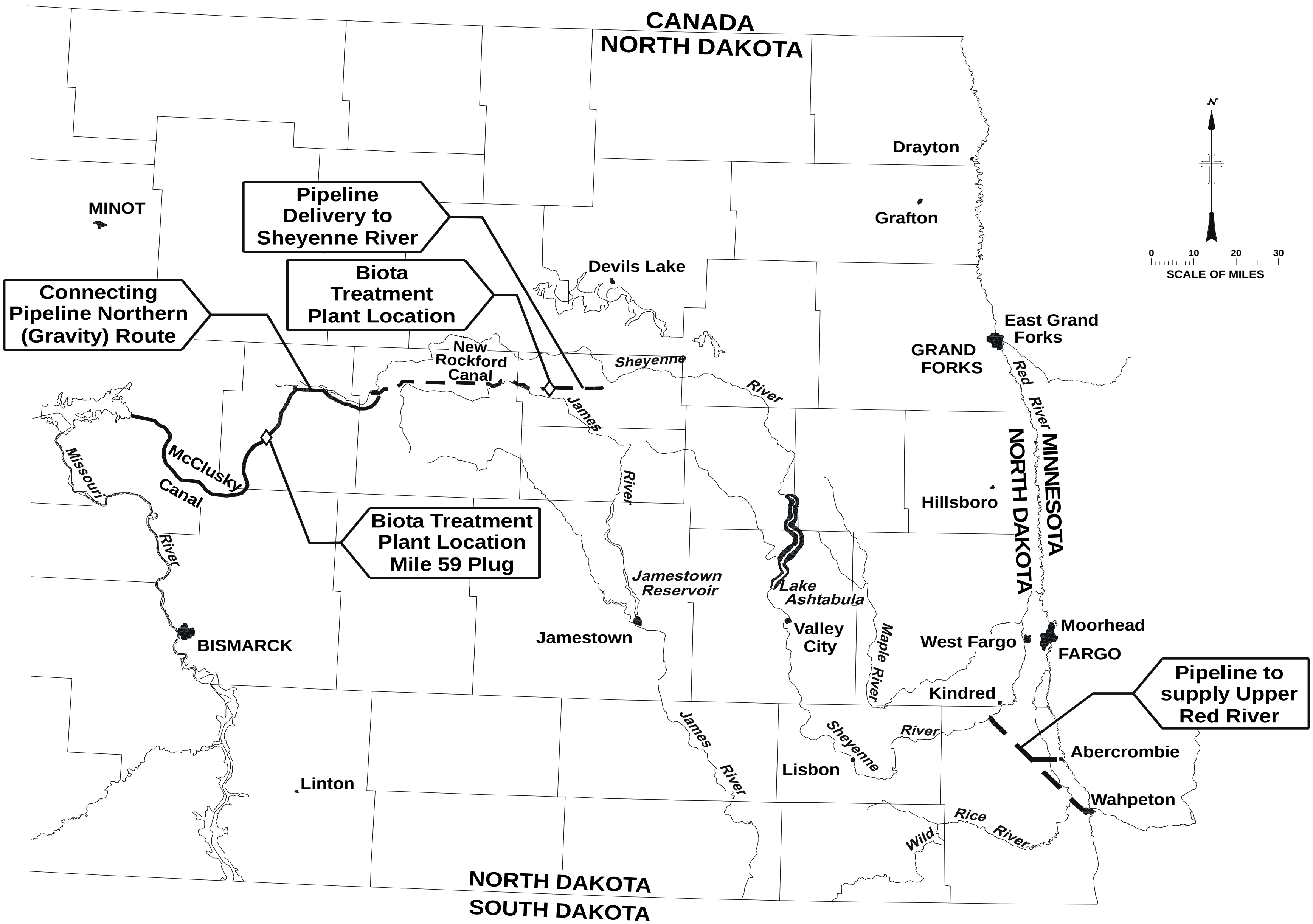


Figure 6.8.—Alternative 7C: Import to upper Sheyenne River via northern (gravity flow) route.

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.11) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

These additional parameters also apply to Alternative 7C:

- Lake Ashtabula starts with the conservation pool full (66,600 acre-feet). The justification for this is that if pipeline water is used for base demands, the Lake Ashtabula conservation pool can be reserved to meet peak demands.
- The second treatment plant and the second pipeline (New Rockford Canal to Sheyenne River) deliver a steady 72 cfs year-round, and this flow is reregulated in Lake Ashtabula.
- The first treatment plant and the first pipeline (McClusky Canal to New Rockford Canal) operate at 87 cfs to allow for 15 cfs of losses in the New Rockford Canal.
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.
- Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

**Table 6.11.—Alternative 7C Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---:|---:|---:|
| Snake Creek Pumping Plant Intake Channel | 5,100,000 | | 360,000 |
| McClusky Canal Rehab | 36,900,000 | | 2,630,000 |
| New Rockford Canal Rehab | 8,900,000 | | 630,000 |
| New Rockford Overflow Outlet | 7,000,000 | | 500,000 |
| Pipeline 22 mi. @87 cfs | 44,100,000 | 112,000 | 3,260,000 |
| Pipeline 9.3 mi.@72 cfs | 24,200,000 | 54,000 | 1,780,000 |
| 18 cfs Pumping Plant & Upper Red Pipeline (39.6 mi) | 44,000,000 | 441,000 | 3,580,000 |
| Biota Treatment Plant, 87 cfs | 16,200,000 | 1,546,000 | 2,700,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| Biota Treatment Plant 72 cfs | 14,100,000 | 1,294,000 | 2,300,000 |
| Existing GDU Maintenance [1] | | 2,424,000 | 2,420,000 |
| **Totals** | **305,185,000** | **9,243,000** | **31,000,000** |

[1] See table 6.1.

This import alternative meets all of the projected 2050 Reclamation demands.  Therefore, it can be considered to provide 61,300 acre-feet of MR&I water during the driest year.  Most of this—52,100 acre-feet—is directly attributable to the import; the remainder results from the greater reserves available in Lake Ashtabula at the beginning of the modeled drought period.

This alternative uses existing Garrison Diversion Unit supply works. Costs are included here (table 6.11) for updating and rehabilitation of those facilities, as provided by Reclamation's Dakotas Area Office, and also for constructing an emergency outlet for storm-water discharge from the New Rockford Canal.

Where possible, shortages on the Red River have been shifted to the Sheyenne River in order to take advantage of the import water supply.  Feature 4C is sized to accommodate the shortages that remained on the upper Red River.

### Alternative 7D — Steady 97-cfs Import Using the McClusky Canal and Pipeline Deliveries to the Upper Sheyenne River and to Grand Forks

This is a Missouri River water import alternative.  The import will be via the McClusky Canal with a biota treatment plant (ozonation/chloramine process) at the mile 59 plug.  The discharge from the treatment plant, 97 cfs, will go into a pipeline, which will provide 72 cfs to the Sheyenne River and will carry the other 25 cfs eastward to the area of Grand Forks (figure 6.9). Water supplied to the Sheyenne River will be reregulated in Lake Ashtabula.

A flow of 20 cfs will be provided to the city of Grand Forks primarily for the purpose of water-quality improvement (as Grand Forks has no projected shortages); the other 5 cfs will go to several rural districts.  The estimated future need at Grand Forks is about 40 cfs, based on an average daily demand.  Assuming there are some benefits to both water quality and water treatment costs to the city of Grand Forks, an import of 50% of the average daily demand has been used to supplement the city water supply.  This flow of 20 cfs would help stabilize raw-water quality.   The Lake Ashtabula storage allocation for Grand Forks is offset by the amount of pipeline supply.  The Grand Forks allocation in Lake Ashtabula is then made available for others to use.

The pipeline initially follows the northern, gravity-flow route eastward from the McClusky Canal and then continues eastward along the New Rockford Canal right-of-way.  However, the water remains in the pipeline, and the open New Rockford Canal is not used.  About 3 miles west of Heimdal, the pipeline tees:  72 cfs goes north into the Sheyenne River (at its confluence with Big Slough) and 25 cfs continues on toward Grand Forks.

The central feature of this alternative—the McClusky Canal to Grand Forks pipeline—was not described in chapter 5.  However, the alternative does incorporate three other features that were described there:

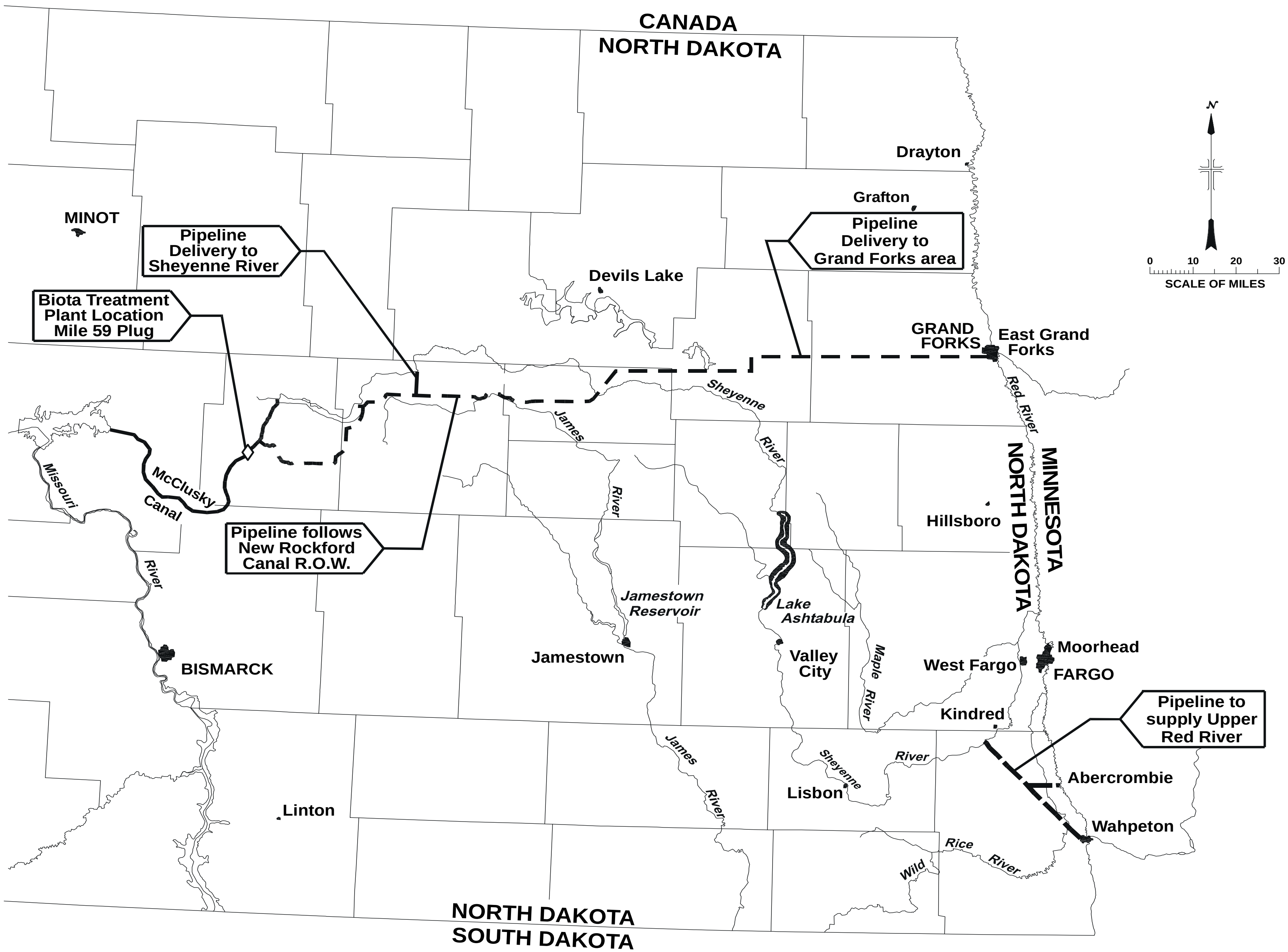


Figure 6.9.—Alternative 7D: Import to upper Sheyenne River and to Grand Forks.

Feature 4C — A water-supply pipeline from the Sheyenne River near Kindred to the upper Red River near Wahpeton, with a branch to Abercrombie. The pipeline and its associated pumping plant provide water at 18 cfs to offset shortages at the existing Cargill plant and at New Industry 3 near Abercrombie.

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 17 — Surface-water supply for rural water systems. Cost estimates included here (table 6.12) provide for multiple river diversions, treatment plants, pumping plants, and main supply pipelines. For modeling purposes, though, the rural system shortages are consolidated demand points located at Fargo and Grand Forks.

These additional parameters also apply to Alternative 7D:

- Lake Ashtabula starts with the conservation pool full (66,600 acre-feet). The justification for this is that if pipeline water is used for base demands, the Lake Ashtabula conservation pool can be reserved to meet peak demands.
- The pipeline delivers a steady 72 cfs to the Sheyenne year-round, and this flow is reregulated in Lake Ashtabula.
- The 28,000 acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.

**Table 6.12.—Alternative 7D Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Snake Creek Pumping Plant Intake Channel | 5,100,000 | | 360,000 |
| McClusky Canal Rehab | 36,900,000 | | 2,630,000 |
| Biota Treatment Plant, 97 cfs | 17,620,000 | 1,710,000 | 2,970,000 |
| Pipeline to Sheyenne R.& extension to Grand Forks [1] | 260,000,000 | 1,480,000 | 20,020,000 |
| Rural Water Distributions | 104,685,000 | 3,372,000 | 10,840,000 |
| 18 cfs Pumping Plant & Upper Red Pipeline (39.6 mi) | 44,000,000 | 440,000 | 3,580,000 |
| Existing GDU Maintenance [2] | | 2,424,000 | 2,420,000 |
| Water Treatment Cost Savings | | –330,000 | –330,000 |
| **Totals** | **468,305,000** | **9,096,000** | **42,490,000** |

[1] Cost shown is projected from an earlier estimate for a larger pipeline (diversion rate of 112 cfs to Sheyenne River and 25 cfs to Grand Forks, 174 miles of pipeline).
[2] See table 6.1.

- Existing water-storage allocation plans may be modified. In this case in particular, Grand Fork's allocation is freed up for use by other cities and industries.
- The 25-cfs import to the Grand Forks area is used to meet base demands at Grand Forks and the participating rural systems; these systems will rely on other water sources to meet peak demands.

This import alternative provides 70,200 acre-feet per year to the Red River Valley, well in excess of the greatest annual MR&I shortage (61,300 acre-feet). It meets all of the projected 2050 Reclamation demands.

This alternative uses some of the existing Garrison Diversion Unit supply works. Table 6.12 includes costs for updating and rehabilitation of the Snake Creek Pumping Plant and the McClusky Canal, as provided by Reclamation's Dakotas Area Office, but does not include costs for the New Rockford Canal or its overflow outlet. The table also shows a cost savings for the Grand Forks municipal treatment plant, reflecting the lower amount of treatment required for imported Missouri River water, compared to the Red River water used now. (See "Raw Water Treatment Cost Analysis" in Appendix 2.)

The import water reaches the Sheyenne River at its confluence with Big Slough. This is several miles upstream from the discharge point for Alternative 7B, and it is unclear whether the river channel at this point has sufficient capacity to accept this amount of import flow. The actual capacity of the river channel and any need for bank stabilization or erosion control have not been assessed for this appraisal-level study.

Where possible, shortages on the Red River have been shifted to the Sheyenne River in order to take advantage of the import water supply. Feature 4C is sized to accommodate the shortages that remained on the upper Red River.

## ALTERNATIVE 8 — WESTERN RED RIVER VALLEY PIPELINE

This is a Missouri River water import alternative, which delivers pretreated water in closed pipelines directly to several cities, industries, and rural water systems (figure 6.10). The amount of water provided has been based upon the model shortages, except for the import to Grand Forks, which serves two other purposes: (1) it provides water of better quality than Grand Forks' current supply, which helps reduce the city's costs of treatment, and (2) it frees up that city's Lake Ashtabula allocation to be available for sale or transfer to others. This alternative incorporates two features (as described in chapter 5):

Feature 12 — Conservation. This is about a 15-percent reduction in demand. However, it is offset by a 15- to 20-percent increase in demand during drought years. (See discussion of this feature in chapter 5.)

Feature 21 — A pipeline distribution system that originates at the east end of the New Rockford Canal and supplies water (82 cfs) for all identified shortages within the

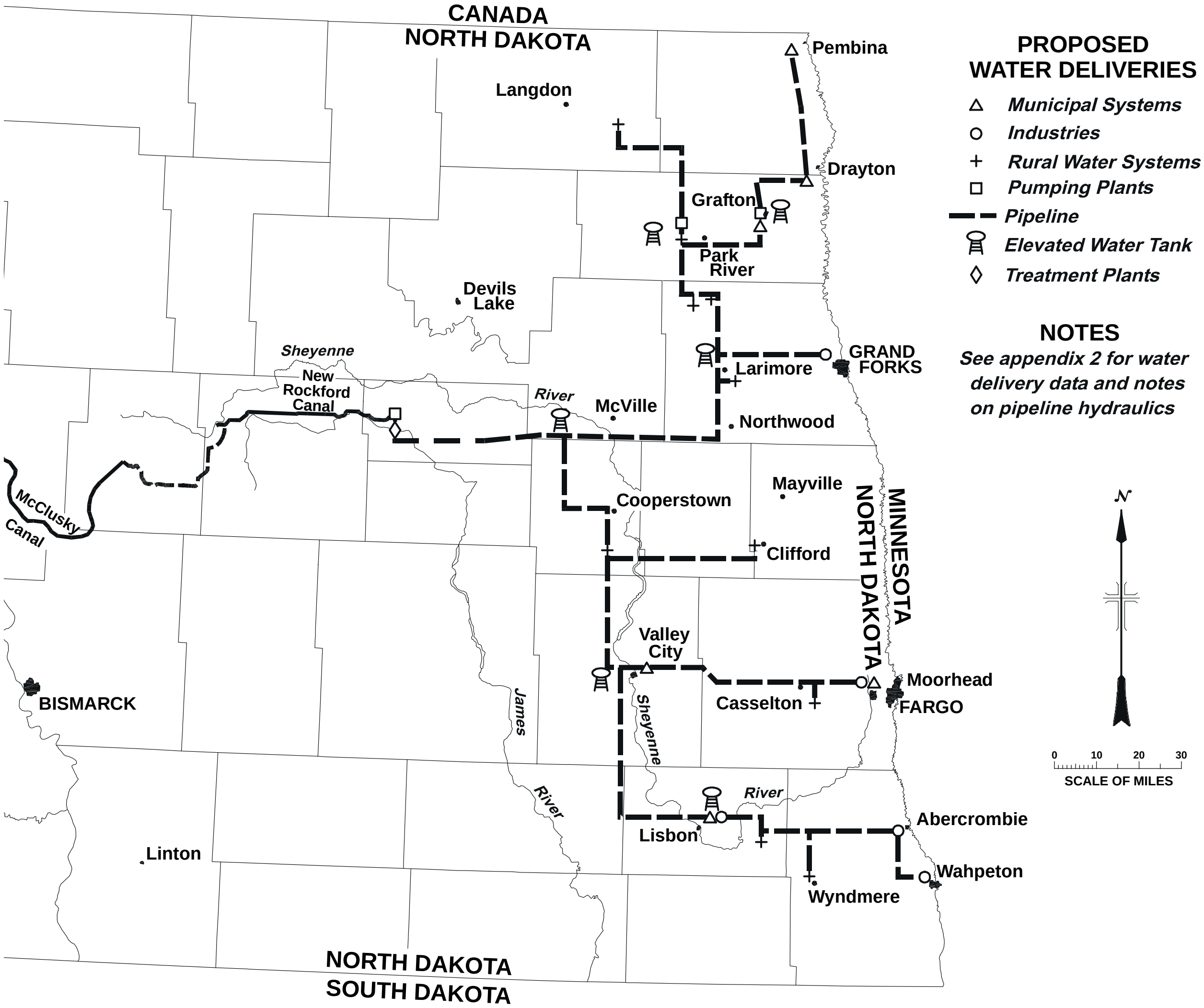


**Figure 6.10.—Alternative 8: Western Red River Valley pipeline.**

study area. Includes biota treatment by ozonation/chloramine method at the end of the New Rockford Canal.

These additional parameters also apply to Alternative 8:

- Lake Ashtabula starts with the conservation pool full (66,600 acre-feet). The justification for this is that if pipeline water is used for base demands, the Lake Ashtabula conservation pool can be reserved to meet peak demands.
- The 28,000-acre-foot minimum pool in Lake Ashtabula is maintained. It will be reserved in case of a drought even more severe than that of the 1930s.
- Existing water-storage allocation plans may be modified. The concept here is to use Lake Ashtabula in the most efficient manner to assist in meeting peak demands during extreme drought.

- The pipeline import is used to meet base demands for all cities and systems served; these users will rely on other water sources to meet peak demands.

The import is computed to meet projected future shortages as well as provide some improved raw water quality to the city of Grand Forks. The estimated future need at Grand Forks is about 40 cfs, based on an average daily demand. Assuming there are some benefits to both water quality and water treatment costs to the city of Grand Forks, an import of 50% of the average daily demand has been used to supplement the city water supply. This flow of 20 cfs would help stabilize raw water quality.

Other supply points have been identified, based on projected future shortages. Some of the rural water system shortages have been consolidated for the purposes of estimating a delivery point and a pipeline location and route. Pipeline sizes and pumping costs have been estimated using the greatest monthly shortages shown in the HYDROSS model output. The HYDROSS simulation of this alternative was completed by working from upstream to downstream on the Sheyenne River and the Red River. As each demand node was met, some natural flows plus return flows were computed for the available downstream flow. For subsequent downstream demands, some of the future shortages were met with the river flows and did not require an additional pipeline supply.

This alternative uses existing Garrison Diversion Unit supply works. Costs are included here (table 6.13) for updating and rehabilitation of those facilities, as provided by Reclamation's Dakotas Area Office, and also for constructing an emergency outlet for storm-water discharge from the New Rockford Canal.

**Table 6.13.—Alternative 8 Cost Summary**

(Costs in dollars)

| Feature | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| Snake Creek Pumping Plant | 5,100,000 | | 360,000 |
| McClusky Canal Rehab | 36,900,000 | | 2,630,000 |
| New Rockford Canal Rehab | 8,900,000 | | 630,000 |
| McClusky to New Rockford Canal, Mo. Coteau Route | 90,600,000 | 1,930,000 | 8,390,000 |
| Biota Treatment Plant 82 cfs | 15,800,000 | 1,500,000 | 2,630,000 |
| Pipeline & Appurtenances | 750,000,000 | 3,440,000 | 56,930,000 |
| New Rockford Overflow Outlet | 7,000,000 | | 500,000 |
| Existing GDU Maintenance [1] | | 2,424,000 | 2,420,000 |
| Water Treatment Cost Savings | | –950,000 | –950,000 |
| **Totals** | **914,300,000** | **8,344,000** | **73,540,000** |

[1] See table 6.1.

Treatment plant costs are included in table 6.13 not only for the biota treatment at the end of the New Rockford Canal, but also for additional treatment rural systems will need to provide before they can deliver the imported water to customers. On the other hand, the table shows a cost savings for the municipal treatment plants at Fargo and Grand Forks, reflecting the lower amount of treatment required for imported Missouri River water, compared to the Red River water used now. (See "Raw Water Treatment Cost Analysis" in Appendix 2.) Table 6.13 also includes costs for all pipelines and appurtenances, including the delivery pipelines, pumping plants, and water storage tanks.

## ALTERNATIVE COST SUMMARY

Table 6.14 summarizes costs for all of the alternatives.

**Table 6.14.—Summary of Costs for All Alternatives**

(Costs in dollars)

| Alternative | Construction Cost | Annual OM&R | Annualized Cost |
|---|---|---|---|
| 2 | 273,995,000 | 6,396,000 | 25,930,000 |
| 3 | 245,862,000 | 3,976,000 | 21,500,000 |
| 4 | 765,821,000 | 15,557,000 | 70,180,000 |
| 5A | 682,045,000 | 9,469,000 | 58,120,000 |
| 5B | 706,295,000 | 9,734,000 | 60,110,000 |
| 6 | 595,895,000 | 9,760,000 | 52,260,000 |
| 7A | 329,185,000 | 9,341,000 | 32,810,000 |
| 7B | 275,985,000 | 7,850,000 | 27,540,000 |
| 7C | 305,185,000 | 9,243,000 | 31,000,000 |
| 7D | 468,305,000 | 9,096,000 | 42,490,000 |
| 8 | 914,300,000 | 8,344,000 | 73,540,000 |